



Global Hydrology and Climate Center



NASA Marshall Space Flight Center and Global Hydrology and Climate Center Contributions to GPM

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GPM Planning Meeting
University of Maryland Inn and Conference Center
May 16-18, 2001



Global Hydrology and Climate Center

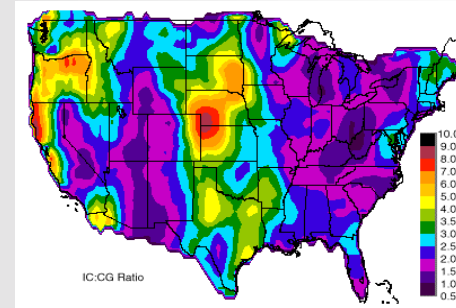


Research Topics:

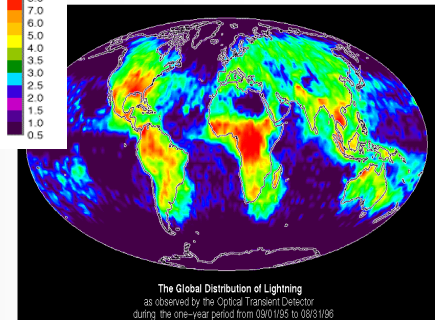
- *Lightning measurements from space*
- *Global temperature*
- *Urban environment studies*
- *Severe weather physics*
- *Global and regional weather/climate modeling*
- *Atmospheric chemistry and pollution*
- *Aerosol measurements and effects on climate*
- *Remote-sensing land use studies*

What we do:

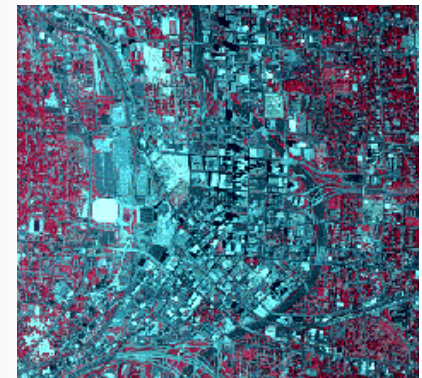
- *Utilize space and other technology to better understand climate*
- *Apply results to resource & environmental management*
- *Educate next generation Earth scientists*



Research



Education



Applications



Global Hydrology and Climate Center



Historical MSFC / GHCC Science Strengths Particularly Relevant to GPM

- Passive microwave data stream processing, product generation, distribution
- Regional integrated field measurements for precipitation process studies, air / ground truthing, validation
- Lightning measurements from space and integration with precipitation science and applications
- Spectrum of water and energy cycle science studies embracing climate variability, precipitation algorithm development, regional modeling, hydrologic applications

Passive Microwave Processing at GHCC

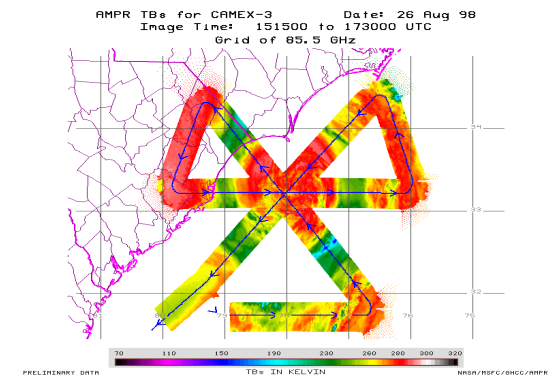
- **Special Sensor Microwave Imager Products** (<http://ghrc.msfc.nasa.gov>)
 - Producing derived geophysical products based upon Wentz / Remote Sensing Systems (RSS) algorithms (1987-present)
 - WetNet project supported SSM/I processing and global algorithm precip analysis (PIP-1, PIP-2, PIP-3)
- **Passive Microwave ESIP** (<http://pm-esip.msfc.nasa.gov>)
 - Ingesting AMSU and TMI data streams (1997 – present)
 - Generating global temperatures and tropical cyclone max. wind products
 - RSS generates TMI products, GHCC archives and distributes
- **Advanced Microwave Scanning Radiometer-EOS SIPS on Aqua**
 - In 2002-2009 will produce full range of Level-2B & -3 products (e.g., rain rate and type, water vapor, SST, cloud water, wind speed, sea ice, etc.)
- **Lightning Imaging Sensor SCF** (<http://thunder.msfc.nasa.gov>)
 - Ingesting LIS data on TRMM and surface validation data sets
 - Produces daily, weekly, and monthly lightning products
- **Field Experiments** (<http://ghrc.msfc.nasa.gov/camex>)
 - CAMEX-3 and -4 hurricane research
 - TRMM surface validation (TRMM-Brazil, TEFLUN)

GHCC Data Processing Role in GPM

- Serve as a data center for generation, archive, and distribution of data sets and products from the:
 - Advanced TMI (ATMI)
 - Constellation Microwave Radiometers (CMRs)
- Continue heritage of SSMI data products with ingest generation of geophysical products from SSMIS temperature data records
- Serve as a ground validation data center

GHCC Strengths in Field Measurements

- **Aircraft Instrumentation**
- **Newly-selected UAV project**
 - (Richard Blakeslee -- ACES)
- **Ground-based Instrumentation**
- **Mission Science Leadership**
 - CoHMEX, CAMEX-3, CAMEX-4
- **In-house**
 - Modeling and Data Assimilation
 - Data Management and Data Mining
 - Educational Outreach
 - Graduate Student Pool



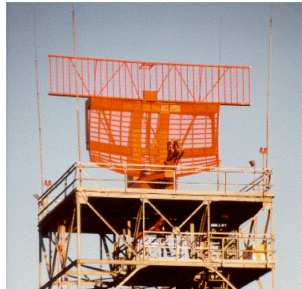
STORMnet

Severe Thunderstorm Observation and Research Monitoring Network

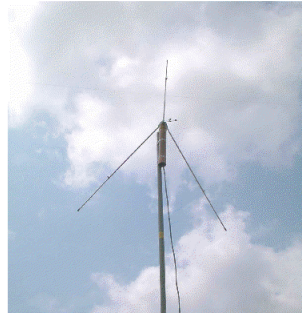
A unique network of advanced weather sensors utilizing multi-agency resources



VWSR-88D Doppler radar
(Storm circulation & boundary mapping)



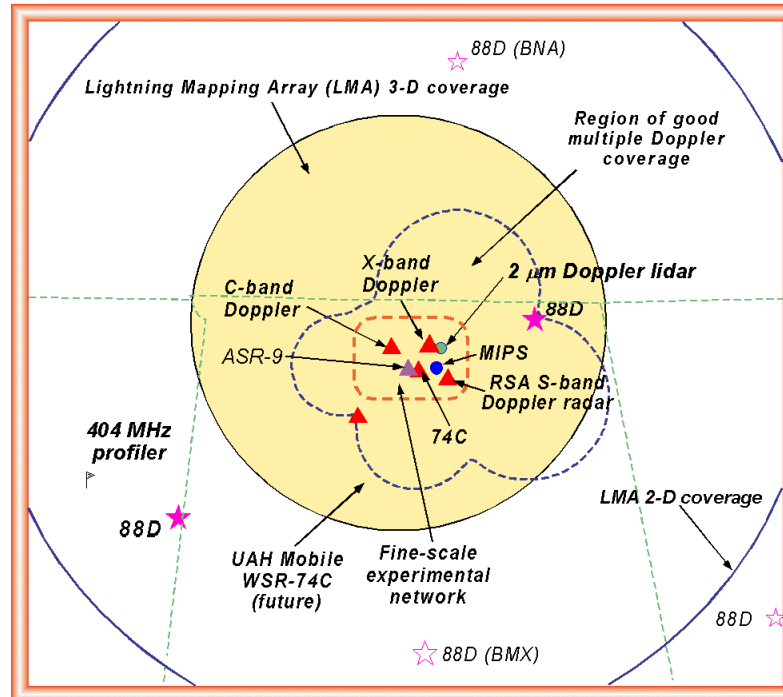
Airport Surveillance Radar (ASR-9)
(Boundary detection within 60 km)



Lightning Mapping Array (LMA, 13 sites)
(Lightning frequency and location)

What parameters need to be measured for improved severe storms detection?

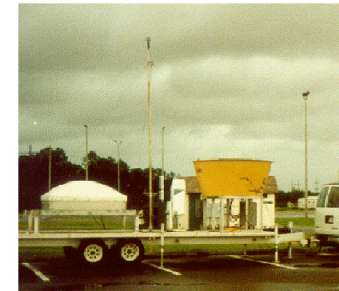
Atmospheric stability + Horizontal wind profile
Location of boundaries + Boundary layer forcing
Storm-scale circulation + Damaging wind mapping
3-D lightning mapping + Total lightning frequency
= Improved detection of severe storms and tornadoes



Research → Technology Transfer



WSR-74C and other Doppler radars
(Storm circulation & boundary mapping)



Mobile Integrated Profiling System (MIPS)
Boundary characterization & storm environment



Automated surface observing system (ASOS)
(boundary layer forcing and boundary location)



COOPERATIVE HUNTSVILLE-AREA RAINFALL MEASUREMENTS (CHARM) NETWORK

Local precipitation network (est. 1/2001)

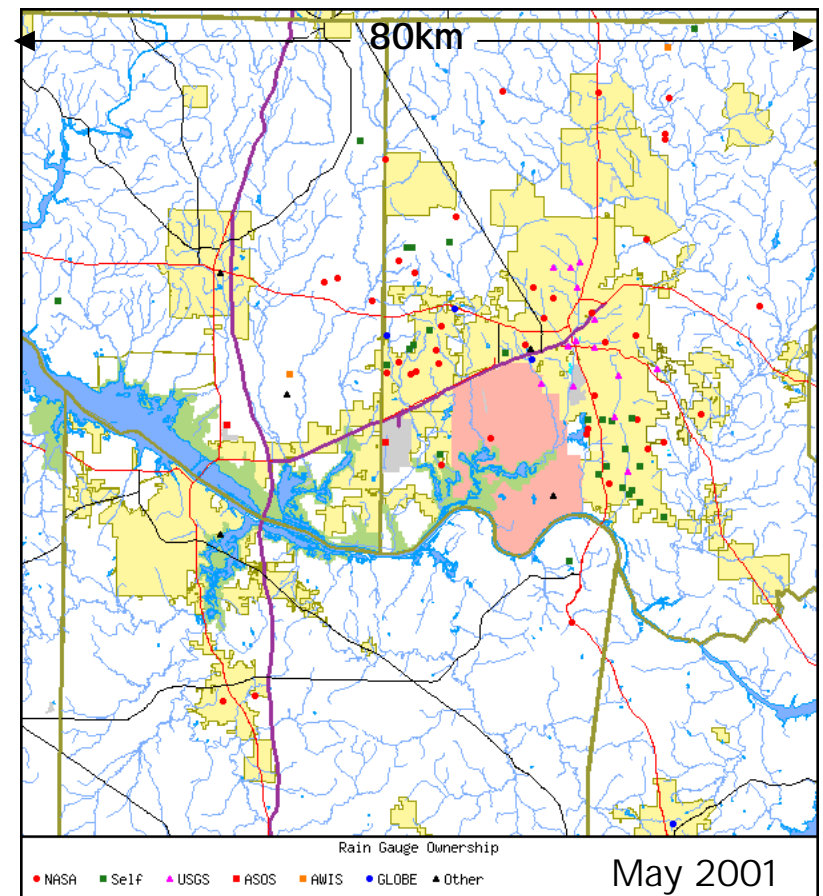
96 sites in Huntsville & Madison County, AL

- NASA, Army, USGS, and NWS sites and weather enthusiasts
- Daily rainfall totals
- 3600 km² coverage (1 gauge per 6x6 km)
- Plans to expand to 200 stations by 2003
4x4 km average spacing
twice daily manual observations
1 minute data from 40 automated sites

Supports local weather and climate research at the GHCC

- validate weather radar and lightning data from satellites
- monitor spatial distributions of precipitation for modeling activities
- various satellite remote sensing studies of soil moisture and energy fluxes

CHARM LOCATION MAP
76 manual and 20
automated rain gauges



Water Resources Planning

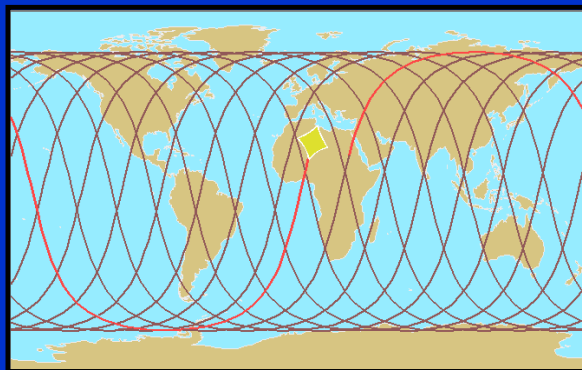
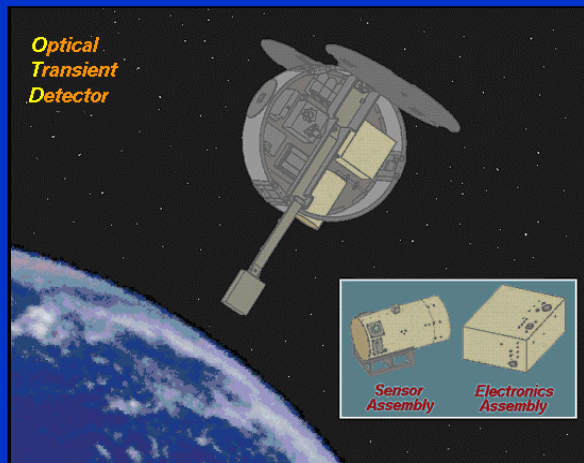
Apalachicola-Chattahoochee-Flint (ACF) and Alabama-Coosa-Tallapoosa (ACT) river basins of Alabama, Georgia, and Florida.

- The ACF and ACT basins are the subject of a comprehensive river basin study involving many stakeholders.
- MSFC locating, assessing, collecting relevant data bases
- A tri-state compact and water allocation formula is currently being negotiated between the states and U.S. Army Corps of Engineers (COE) that will affect the availability of water among competing uses within the ACF river basin.

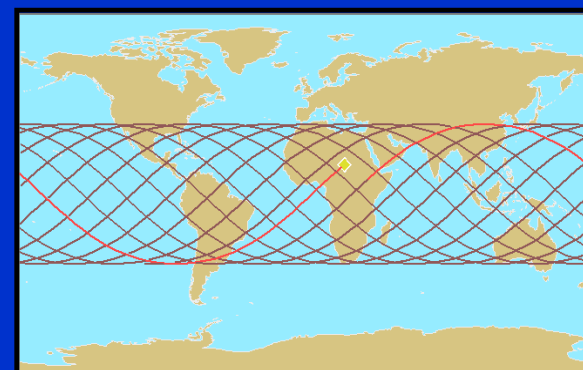
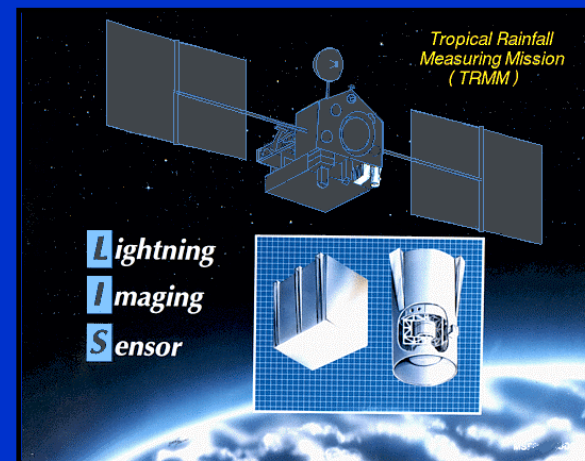


Lightning Detection from Low Earth Orbit

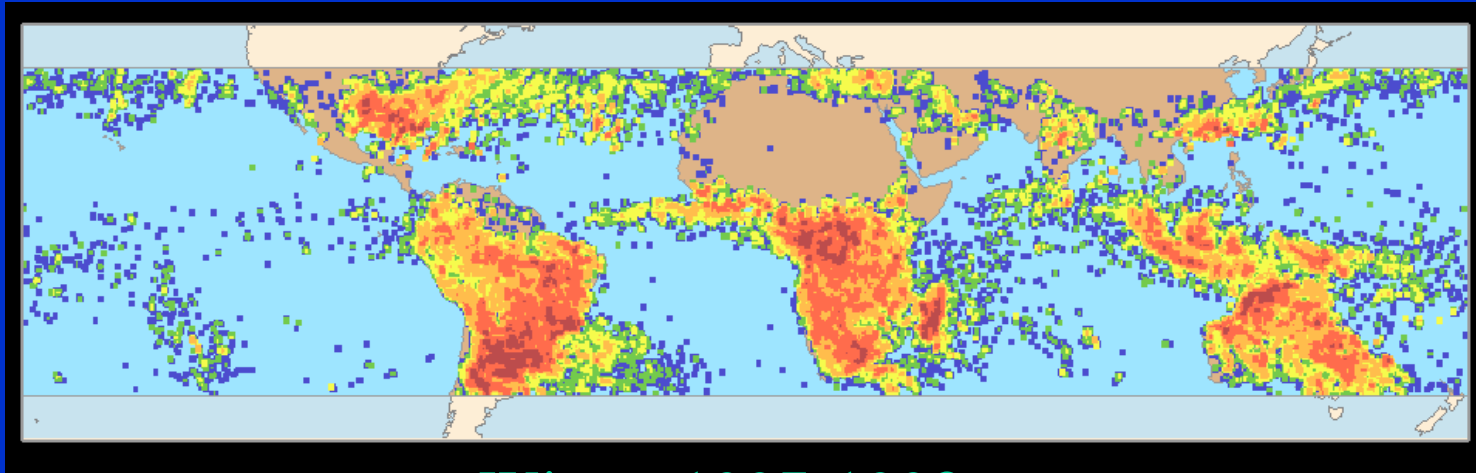
Optical Transient Detector
(launched April, 1995)



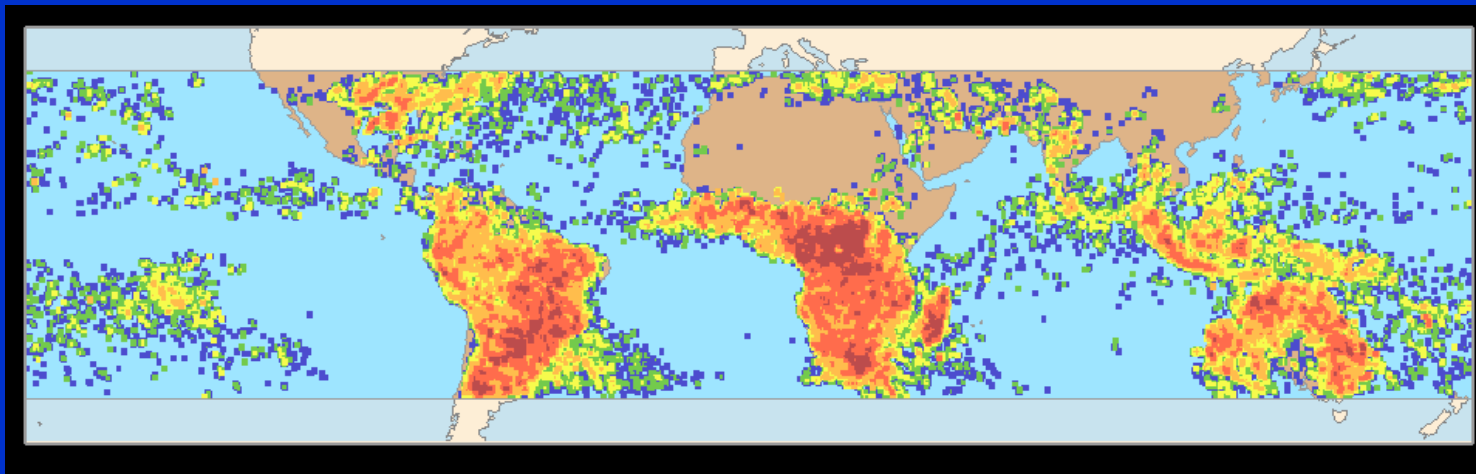
Lightning Imaging Sensor
(launched November, 1997)



LIS: ENSO vs non-ENSO years



Winter 1997-1998



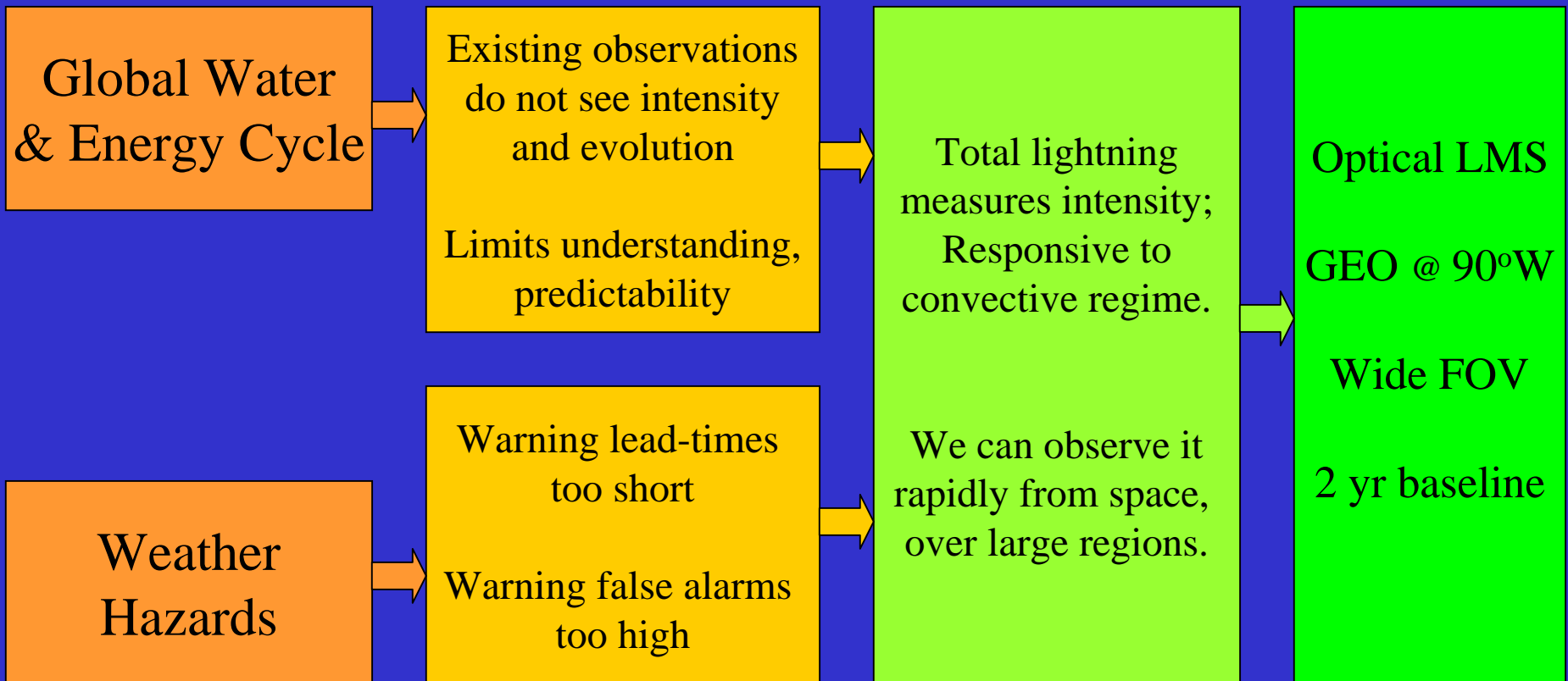
Winter 1998-1999

ESE Objectives

Key Problems

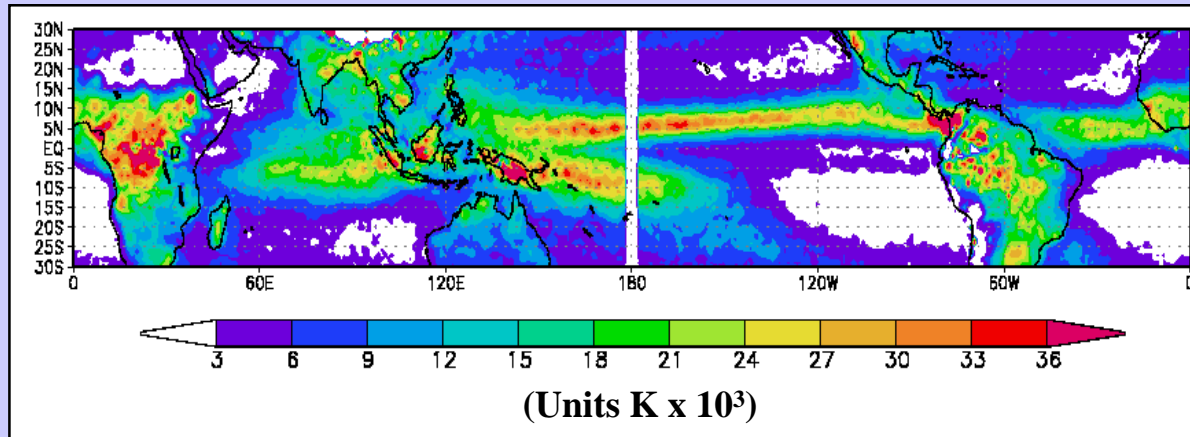
Enablers

ThOR Mission



Tropical Deep Convective Ice Index Climatology Synthesized From MSU Ch2

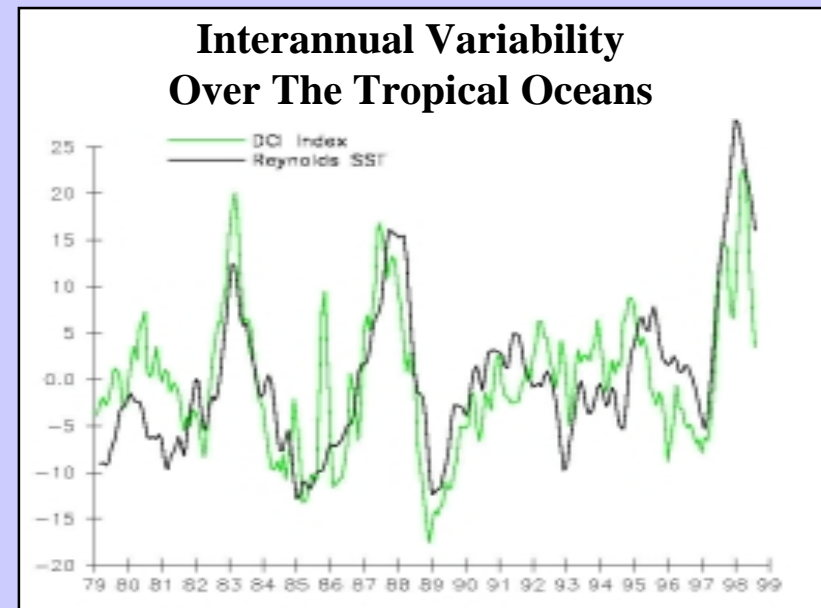
--- A new data set for climate diagnostics and model validation ---



Precipitating ice formed high within tropical rain storms produces local Tb minima in MSU Ch2 data.

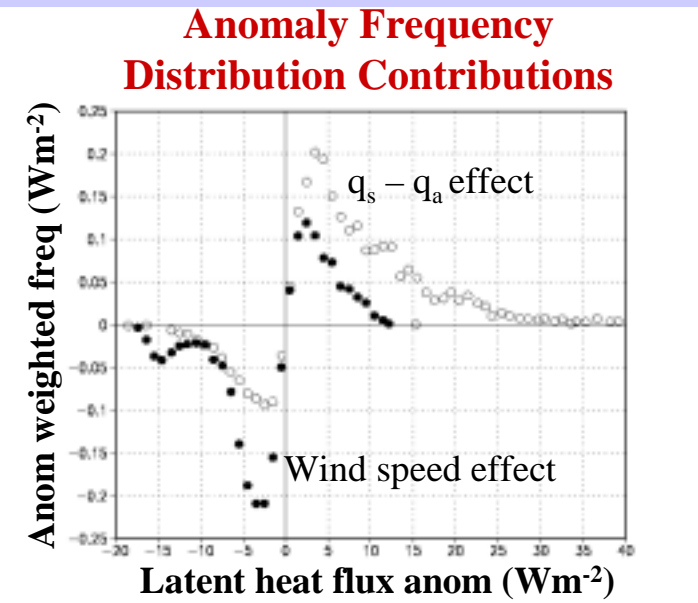
- Deep convective ice index, DCI, (green line) expressed in percent departure from normal. SST departures from climatology in Kelvin x 50.
- Averaged over the tropical oceans, year-to-year variations in precipitating ice follow variations in sea-surface temperatures.

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MSFC Climate Dynamics and Modeling Group

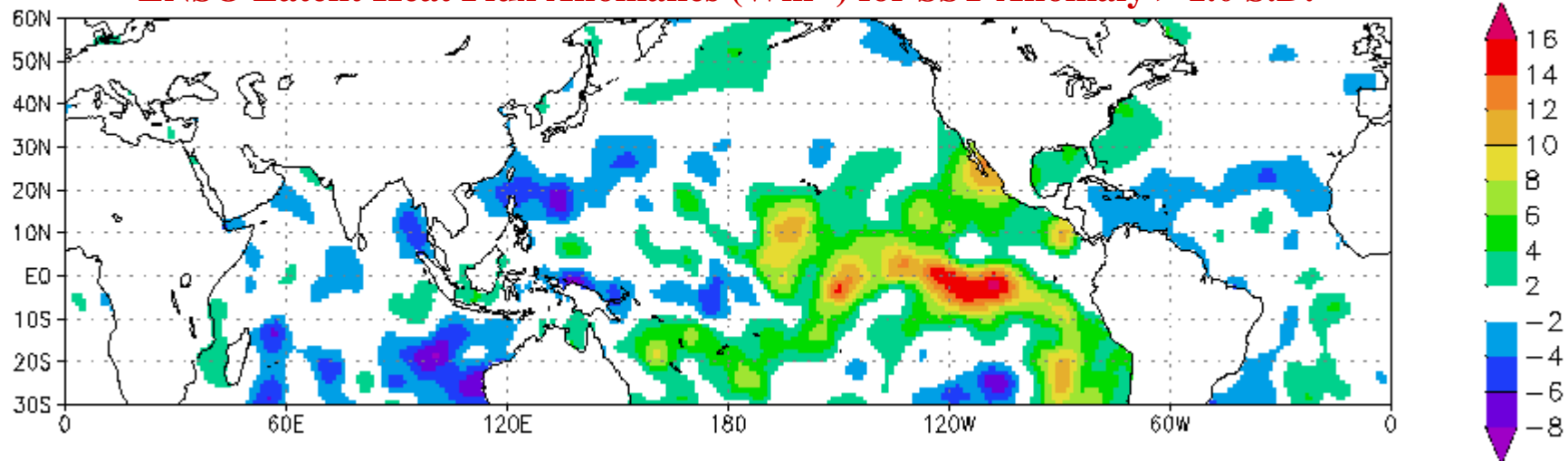


Evaporation / SST Sensitivity Over the Tropical Oceans During ENSO Events

- ENSO composite data from da Silva, Young, Levitus Surface Marine Data Set
- Tropical-mean SST perturbations during ENSO raise ocean-mean latent heat fluxes at rate of $\sim 5.0 \text{ Wm}^{-2} \text{ K}^{-1}$
- Thermodynamic anomalies, $\delta(q_s - q_a)$, dominate wind anomaly effects, δWSPD .



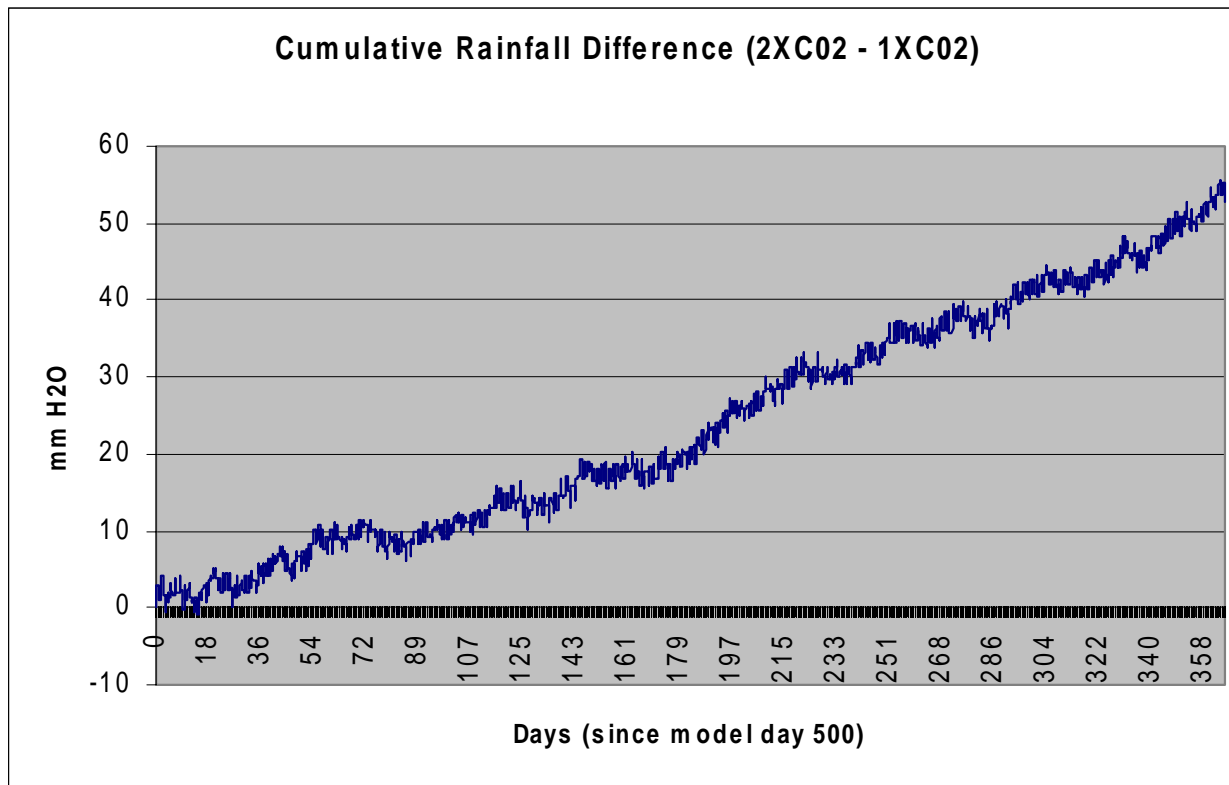
ENSO Latent Heat Flux Anomalies (Wm^{-2}) for SST Anomaly > 1.0 S.D.



Using Advanced Regional Prediction System (ARPS) to Study the Coupled Hydrologic response to 2 X CO2

(Contact: Roy Spencer, Danny Braswell)

- 1000 model day runs
- 2-D, 1 Km res, 12 sec time step
- Tropical domain
- Persistent solar flux with diurnal cycle (May)
- Software enhancements to insure water conservation
- *ARPS provided by CAPS at the University of Oklahoma*



Cumulative difference in rainfall for normal and doubled CO2 over a 1 year period after model equilibration shows invigorated hydrologic cycle.

Assimilating Remotely Sensed Soil Moisture in a Hydrologic Model

- Precipitation is a primary input to surface hydrologic models.
- Remotely sensed soil moisture is complementary to rainfall data and can be assimilated to improve hydrologic model performance.

